

1. An apparatus for photonic transceiving, the apparatus comprising:
 - a photonic receiving path configured to carry a received photonic signal having a received wavelength;
 - a spectrum replicater configured to receive and spectrally replicate the received photonic
 - 5 signal to provide a replicated photonic signal;
 - a narrowband filter configured to receive and bandpass filter the replicated photonic signal to provide a transmitted photonic signal; and
 - a photonic transmit path configured to carry the transmitted photonic signal from the narrowband filter toward a destination.
- 10 2. The apparatus of claim 1, wherein the narrowband filter is tunable to an arbitrary range of wavelength.
3. The apparatus of claim 1, wherein the narrowband filter comprises:
 - 15 a circulator having first, second and third ports, the circulator configured to receive at the first port and circulate the replicated photonic signal to the second port;
 - a reflecting filter operably connected to the second port to receive and selectively reflect the replicated photonic signal, to provide a reflected photonic signal into the circulator at the second port; and
 - 20 an output path configured to receive from the third port the reflected photonic signal as the transmitted photonic signal.

4. The apparatus of claim 1, wherein the spectrum replicater comprises a wavelength shifter.

5. The apparatus of claim 4, wherein the wavelength shifter comprises:

a modulation device characterized by a modulation waveform and configured to modulate
5 the received photonic signal in accordance therewith a modulation waveform to provide a shifted
photonic signal having a shifted wavelength; and

a modulation synthesizer configured to provide the modulation waveform to the
modulation device.

10 6. The apparatus of claim 5, wherein the modulation synthesizer is further configured to
provide the modulation waveform to the modulation device effective to shift the received
wavelength to a plurality of shifted wavelengths.

15 7. The apparatus of claim 1, wherein the spectrum replicater comprises a recursive
wavelength shifter.

8. The apparatus of claim 7, wherein the recursive wavelength shifter comprises:

a combiner configured to combine a shifted photonic signal having a shifted wavelength with the received photonic signal to provide a combined photonic signal;

an amplifier operably connected to the combiner to amplify the combined photonic signal into an amplified photonic signal;

a splitter operably connected to split the amplified photonic signal into the replicated photonic signal and a photonic feedback signal having a feedback wavelength; and

a wavelength shifter configured to wavelength shift the photonic feedback signal to provide the shifted photonic signal.

9. The apparatus of claim 8, wherein the wavelength shifter comprises:

a modulation device configured to modulate the photonic feedback signal in accordance with a modulation waveform; and

a modulation synthesizer configured to provide the modulation waveform to the modulation device.

10. The apparatus of claim 1, wherein the spectrum replicater is a spectral comb replicater.

11. The apparatus of claim 8, wherein the spectral comb replicater comprises:

a splitter configured to split the received photonic signal into first and second split photonic signals;

5 a first recursive wavelength shifter configured to recursively wavelength shift the first split photonic signal with a positive wavelength shift to provide a first replicated photonic signal;

a second recursive wavelength shifter configured to recursively wavelength shift the second received photonic signal with a negative wavelength shift to provide a second replicated photonic signal; and

10 a combiner configured to combine the first and second replicated photonic signals to provide the replicated photonic signal.

12. The apparatus of claim 1, wherein the spectrum replicater comprises a four-wave-mixer.

13. The apparatus of claim 12, wherein the four-wave mixer further comprises:

15 a photonic mixing path configured to carry a photonic mixing signal having at least one mixing wavelength;

a combiner configured to combine the received photonic signal with the photonic mixing signal to provide a combined photonic signal;

20 an amplifier configured to provide non-linear amplification to the combined photonic signal to provide a non-linear photonic signal; and

a splitter configured to split the non-linear photonic signal to provide the replicated photonic signal;

14. The apparatus of claim 1, wherein the spectrum replicater comprises a recursive four-wave-mixer.

15. The apparatus of claim 14, wherein the recursive four-wave mixer comprises:

5 a photonic mixing path configured to carry a photonic mixing signal having a mixing wavelength;

a combiner configured to combine a photonic feedback signal with the received photonic signal and the photonic mixing signal to provide a combined photonic signal;

10 an amplifier configured to provide non-linear amplification to the combined photonic signal to provide a non-linear photonic signal; and

a splitter configured to split the non-linear photonic signal to provide the replicated photonic signal and the photonic feedback signal;

17. The apparatus of claim 16, wherein each of the first and second recursive wavelength shifters comprise:

a photonic input path configured to carry a photonic input signal;

a photonic output path configured to carry a photonic output signal;

5 a combiner configured to combine a shifted photonic signal, having a shifted wavelength, with the photonic input signal to provide a combined photonic signal;

an amplifier configured to amplify the combined photonic signal to provide an amplified photonic signal;

10 a splitter configured to split the amplified photonic signal to provide the photonic output signal and a photonic feedback signal having a feedback wavelength; and

a wavelength shifter configured to wavelength shift the photonic feedback signal to provide the shifted photonic signal.

18. The apparatus of claim 17, wherein the wavelength shifter comprises:

15 a modulation device configured to modulate the photonic feedback signal in accordance with a modulation waveform to provide the shifted photonic signal; and

a modulation synthesizer configured to provide the modulation waveform to the modulation device effective to shift the feedback wavelength to the shifted wavelength.